

## **IN THE CLAIMS**

1-19. (Cancelled)

20. (New) A human glycoprotein hormone family protein comprising at least one electrostatic charge altering mutation in a  $\beta$  hairpin loop structure of a human chorionic gonadotropin (CG)  $\beta$  subunit, wherein the at least one electrostatic charge altering mutation is in the L1  $\beta$  hairpin loop at a position selected from the group consisting of positions 1-37 or 58-87 as shown in SEQ ID NO:3, wherein the at least one electrostatic charge altering mutation comprises at least one basic residue introducing mutation selected from the group consisting of S1B, E3B, P4B, L5B, P7B, R8B, C9B, P11B, I12B, N13B, A14B, T15B, L16B, A17B, V18B, E19B, G22B, C23B, V25B, C26B, I27B, T28B, V29B, N30B, T31B, T32B, I33B, C34B, A35B, G36B, Y37B, N58B, Y59B, D61B, V62B, F64B, S66B, I67B, L69B, P70B, P73B, V76B, N77B, V80B, S81B, Y82B, A83B, V84B, A85B, L86B, and S87B, wherein B is a basic amino acid residue, or wherein the at least one electrostatic charge altering mutation comprises at least one acidic residue introducing mutation selected from the group consisting of S1Z, K2Z, P4Z, L5Z, R6Z, P7Z, R8Z, C9Z, R10Z, P11Z, I12Z, N13Z, A14Z, T15Z, L16Z, A17Z, V18Z, K20Z, C23Z, P24Z, V25Z, C26Z, I27Z, T28Z, V29Z, N30Z, T31Z, T32Z, I33Z, C34Z, A35Z, G36Z, Y37Z, N58Z, Y59Z, R60Z, V62Z, R63Z, F64Z, S66Z, I67Z, L69Z, P70Z, G71Z, C72Z, P73Z, R74Z, G75Z, V76Z, V79Z, V80Z, S81Z, Y82Z, A83Z, V84Z, A85Z, L86Z, and S87Z wherein Z is an acidic amino acid residue, or wherein the at least one electrostatic charge altering mutation comprises at least one neutral residue introducing mutation selected from the group consisting of K2U, E3U, R10U, E19U, E21U, R60U, D61U, R63U, E65U, and R68U wherein U is a neutral amino acid.

21. (New) The protein according to Claim 20, wherein the mutation is a basic residue introducing mutation.

22. (New) The protein according to Claim 21, wherein the mutation is S1B.
23. (New) The protein according to Claim 21, wherein the mutation is E3B.
24. (New) The protein according to Claim 21, wherein the mutation is P4B.
25. (New) The protein according to Claim 21, wherein the mutation is L5B.
26. (New) The protein according to Claim 21, wherein the mutation is P7B.
27. (New) The protein according to Claim 21, wherein the mutation is R8B.
28. (New) The protein according to Claim 21, wherein the mutation is C9B.
29. (New) The protein according to Claim 21, wherein the mutation is P11B.
30. (New) The protein according to Claim 21, wherein the mutation is I12B.
31. (New) The protein according to Claim 21, wherein the mutation is N13B.
32. (New) The protein according to Claim 21, wherein the mutation is A14B.
33. (New) The protein according to Claim 21, wherein the mutation is T15B.
34. (New) The protein according to Claim 21, wherein the mutation is L16B.
35. (New) The protein according to Claim 21, wherein the mutation is A17B.
36. (New) The protein according to Claim 21, wherein the mutation is V18B.
37. (New) The protein according to Claim 21, wherein the mutation is E19B.
38. (New) The protein according to Claim 21, wherein the mutation is G22B.
39. (New) The protein according to Claim 21, wherein the mutation is C23B.
40. (New) The protein according to Claim 21, wherein the mutation is V25B.
41. (New) The protein according to Claim 21, wherein the mutation is C26B.
42. (New) The protein according to Claim 21, wherein the mutation is I27B.
43. (New) The protein according to Claim 21, wherein the mutation is T28B.
44. (New) The protein according to Claim 21, wherein the mutation is V29B.
45. (New) The protein according to Claim 21, wherein the mutation is N30B.

46. (New) The protein according to Claim 21, wherein the mutation is T31B.
47. (New) The protein according to Claim 21, wherein the mutation is T32B.
48. (New) The protein according to Claim 21, wherein the mutation is I33B.
49. (New) The protein according to Claim 21, wherein the mutation is C34B.
50. (New) The protein according to Claim 21, wherein the mutation is A35B.
51. (New) The protein according to Claim 21, wherein the mutation is G36B.
52. (New) The protein according to Claim 21, wherein the mutation is Y37B.
53. (New) The protein according to Claim 21, wherein the mutation is N58B.
54. (New) The protein according to Claim 21, wherein the mutation is Y59B.
55. (New) The protein according to Claim 21, wherein the mutation is D61B.
56. (New) The protein according to Claim 21, wherein the mutation is V62B.
57. (New) The protein according to Claim 21, wherein the mutation is F64B.
58. (New) The protein according to Claim 21, wherein the mutation is S66B.
59. (New) The protein according to Claim 21, wherein the mutation is I67B.
60. (New) The protein according to Claim 21, wherein the mutation is L69B.
61. (New) The protein according to Claim 21, wherein the mutation is P70B.
62. (New) The protein according to Claim 21, wherein the mutation is P73B.
63. (New) The protein according to Claim 21, wherein the mutation is V76B.
64. (New) The protein according to Claim 21, wherein the mutation is N77B.
65. (New) The protein according to Claim 21, wherein the mutation is V80B.
66. (New) The protein according to Claim 21, wherein the mutation is S81B.
67. (New) The protein according to Claim 21, wherein the mutation is Y82B.
68. (New) The protein according to Claim 21, wherein the mutation is A83B.
69. (New) The protein according to Claim 21, wherein the mutation is V84B.

70. (New) The protein according to Claim 21, wherein the mutation is A85B.

71. (New) The protein according to Claim 21, wherein the mutation is L86B.

72. (New) The protein according to Claim 21, wherein the mutation is S87B.

73. (New) The protein according to Claim 20, wherein the mutation is an acidic residue introducing mutation.

74. (New) The protein according to Claim 73, wherein the mutation is S1Z.
75. (New) The protein according to Claim 73, wherein the mutation is K2Z.
76. (New) The protein according to Claim 73, wherein the mutation is P4Z.
77. (New) The protein according to Claim 73, wherein the mutation is L5Z.
78. (New) The protein according to Claim 73, wherein the mutation is R6Z.
79. (New) The protein according to Claim 73, wherein the mutation is P7Z.
80. (New) The protein according to Claim 73, wherein the mutation is R8Z.
81. (New) The protein according to Claim 73, wherein the mutation is C9Z.
82. (New) The protein according to Claim 73, wherein the mutation is R10Z.
83. (New) The protein according to Claim 73, wherein the mutation is P11Z.
84. (New) The protein according to Claim 73, wherein the mutation is I12Z.
85. (New) The protein according to Claim 73, wherein the mutation is N13Z.
86. (New) The protein according to Claim 73, wherein the mutation is A14Z.
87. (New) The protein according to Claim 73, wherein the mutation is T15Z.
88. (New) The protein according to Claim 73, wherein the mutation is L16Z.
89. (New) The protein according to Claim 73, wherein the mutation is A17Z.
90. (New) The protein according to Claim 73, wherein the mutation is V18Z.
91. (New) The protein according to Claim 73, wherein the mutation is K20Z.
92. (New) The protein according to Claim 73, wherein the mutation is C23Z.

93. (New) The protein according to Claim 73, wherein the mutation is P24Z.
94. (New) The protein according to Claim 73, wherein the mutation is V25Z.
95. (New) The protein according to Claim 73, wherein the mutation is C26Z.
96. (New) The protein according to Claim 73, wherein the mutation is I27Z.
97. (New) The protein according to Claim 73, wherein the mutation is T28Z.
98. (New) The protein according to Claim 73, wherein the mutation is V29Z.
99. (New) The protein according to Claim 73, wherein the mutation is N30Z.
100. (New) The protein according to Claim 73, wherein the mutation is T31Z.
101. (New) The protein according to Claim 73, wherein the mutation is T32Z.
102. (New) The protein according to Claim 73, wherein the mutation is I33Z.
103. (New) The protein according to Claim 73, wherein the mutation is C34Z.
104. (New) The protein according to Claim 73, wherein the mutation is A35Z.
105. (New) The protein according to Claim 73, wherein the mutation is G36Z.
106. (New) The protein according to Claim 73, wherein the mutation is Y37Z.
107. (New) The protein according to Claim 73, wherein the mutation is N58Z.
108. (New) The protein according to Claim 73, wherein the mutation is Y59Z.
109. (New) The protein according to Claim 73, wherein the mutation is R60Z.
110. (New) The protein according to Claim 73, wherein the mutation is V62Z.
111. (New) The protein according to Claim 73, wherein the mutation is R63Z.
112. (New) The protein according to Claim 73, wherein the mutation is F64Z.
113. (New) The protein according to Claim 73, wherein the mutation is S66Z.
114. (New) The protein according to Claim 73, wherein the mutation is I67Z.
115. (New) The protein according to Claim 73, wherein the mutation is L69Z.
116. (New) The protein according to Claim 73, wherein the mutation is P70Z.

117. (New) The protein according to Claim 73, wherein the mutation is G71Z.
118. (New) The protein according to Claim 73, wherein the mutation is C72Z.
119. (New) The protein according to Claim 73, wherein the mutation is P73Z.
120. (New) The protein according to Claim 73, wherein the mutation is R74Z.
121. (New) The protein according to Claim 73, wherein the mutation is G75Z.
122. (New) The protein according to Claim 73, wherein the mutation is V76Z.
123. (New) The protein according to Claim 73, wherein the mutation is V79Z.
124. (New) The protein according to Claim 73, wherein the mutation is V80Z.
125. (New) The protein according to Claim 73, wherein the mutation is S81Z.
126. (New) The protein according to Claim 73, wherein the mutation is Y82Z.
127. (New) The protein according to Claim 73, wherein the mutation is A83Z.
128. (New) The protein according to Claim 73, wherein the mutation is V84Z.
129. (New) The protein according to Claim 73, wherein the mutation is A85Z.
130. (New) The protein according to Claim 73, wherein the mutation is L86Z.
131. (New) The protein according to Claim 73, wherein the mutation is S87Z.
132. (New) The protein according to Claim 20, wherein the mutation is a neutral residue introducing mutation.
133. (New) The protein according to Claim 132, wherein the mutation is K2U.
134. (New) The protein according to Claim 132, wherein the mutation is E3U.
135. (New) The protein according to Claim 132, wherein the mutation is R10U.
136. (New) The protein according to Claim 132, wherein the mutation is E19U.
137. (New) The protein according to Claim 132, wherein the mutation is E21U.
138. (New) The protein according to Claim 132, wherein the mutation is R60U.
139. (New) The protein according to Claim 132, wherein the mutation is D61U.

140. (New) The protein according to Claim 132, wherein the mutation is R63U.
141. (New) The protein according to Claim 132, wherein the mutation is E65U.
142. (New) The protein according to Claim 132, wherein the mutation is R68U.
143. (New) A human glycoprotein hormone family protein comprising a  $\beta$  hairpin loop structure of a human chorionic gonadotropin (CG)  $\beta$  subunit, as shown in SEQ ID NO: 3, having at least one mutation not in the  $\beta$  hairpin loop structure, and the at least one mutation is selected from the group consisting of C38J, P39J, T40J, M41J, T42J, R43J, V44J, L45J, Q46J, G47J, V48J, L49J, P50J, A51J, L52J, P53J, Q54J, V55J, V56J, C57J, C88J, Q89J, C90J, A91J, L92J, C93J, R94J, R95J, S96J, T97J, T98J, D99J, C100J, G101J, G102J, P103J, K104J, D105J, H106J, P107J, L108J, T109J, C110J, D111J, D112J, P113J, R114J, F115J, Q116J, D117J, S118J, S119J, S120J, S121J, K122J, A123J, P124J, P125J, P126J, S127J, L128J, P129J, S130J, P131J, S132J, R133J, L134J, P135J, G136J, P137J, S138J, D139J, and T140J, wherein the variable J is any amino acid whose introduction results in an increase in the electrostatic interaction between an L1 and L3  $\beta$  hairpin loop structure of the hCG  $\beta$ -subunit and a receptor with affinity for a dimeric protein containing the mutant hCG  $\beta$ -subunit monomer.
144. (New) The protein according to Claim 143, wherein the mutation is C38J.
145. (New) The protein according to Claim 143, wherein the mutation is P39J.
146. (New) The protein according to Claim 143, wherein the mutation is T40J.
147. (New) The protein according to Claim 143, wherein the mutation is M41J.
148. (New) The protein according to Claim 143, wherein the mutation is T42J.
149. (New) The protein according to Claim 143, wherein the mutation is R43J.
150. (New) The protein according to Claim 143, wherein the mutation is V44J.
151. (New) The protein according to Claim 143, wherein the mutation is L45J.
152. (New) The protein according to Claim 143, wherein the mutation is Q46J.

153. (New) The protein according to Claim 143, wherein the mutation is G47J.
154. (New) The protein according to Claim 143, wherein the mutation is V48J.
155. (New) The protein according to Claim 143, wherein the mutation is L49J.
156. (New) The protein according to Claim 143, wherein the mutation is P50J.
157. (New) The protein according to Claim 143, wherein the mutation is A51J.
158. (New) The protein according to Claim 143, wherein the mutation is L52J.
159. (New) The protein according to Claim 143, wherein the mutation is P53J.
160. (New) The protein according to Claim 143, wherein the mutation is Q54J.
161. (New) The protein according to Claim 143, wherein the mutation is V55J.
162. (New) The protein according to Claim 143, wherein the mutation is V56J.
163. (New) The protein according to Claim 143, wherein the mutation is C57J.
164. (New) The protein according to Claim 143, wherein the mutation is C88J.
165. (New) The protein according to Claim 143, wherein the mutation is Q89J.
166. (New) The protein according to Claim 143, wherein the mutation is C90J.
167. (New) The protein according to Claim 143, wherein the mutation is A91J.
168. (New) The protein according to Claim 143, wherein the mutation is L92J.
169. (New) The protein according to Claim 143, wherein the mutation is C93J.
170. (New) The protein according to Claim 143, wherein the mutation is R94J.
171. (New) The protein according to Claim 143, wherein the mutation is R95J.
172. (New) The protein according to Claim 143, wherein the mutation is S96J.
173. (New) The protein according to Claim 143, wherein the mutation is T97J.
174. (New) The protein according to Claim 143, wherein the mutation is T98J.
175. (New) The protein according to Claim 143, wherein the mutation is D99J.
176. (New) The protein according to Claim 143, wherein the mutation is C100J.



177. (New) The protein according to Claim 143, wherein the mutation is G101J.
178. (New) The protein according to Claim 143, wherein the mutation is G102J.
179. (New) The protein according to Claim 143, wherein the mutation is P103J.
180. (New) The protein according to Claim 143, wherein the mutation is K104J.
181. (New) The protein according to Claim 143, wherein the mutation is D105J.
182. (New) The protein according to Claim 143, wherein the mutation is H106J.
183. (New) The protein according to Claim 143, wherein the mutation is P107J.
184. (New) The protein according to Claim 143, wherein the mutation is L108J.
185. (New) The protein according to Claim 143, wherein the mutation is T109J.
186. (New) The protein according to Claim 143, wherein the mutation is C110J.
187. (New) The protein according to Claim 143, wherein the mutation is D111J.
188. (New) The protein according to Claim 143, wherein the mutation is D112J.
189. (New) The protein according to Claim 143, wherein the mutation is P113J.
190. (New) The protein according to Claim 143, wherein the mutation is R114J.
191. (New) The protein according to Claim 143, wherein the mutation is F115J.
192. (New) The protein according to Claim 143, wherein the mutation is Q116J.
193. (New) The protein according to Claim 143, wherein the mutation is D117J.
194. (New) The protein according to Claim 143, wherein the mutation is S118J.
195. (New) The protein according to Claim 143, wherein the mutation is S119J.
196. (New) The protein according to Claim 143, wherein the mutation is S120J.
197. (New) The protein according to Claim 143, wherein the mutation is S121J.
198. (New) The protein according to Claim 143, wherein the mutation is K122J.
199. (New) The protein according to Claim 143, wherein the mutation is A123J.
200. (New) The protein according to Claim 143, wherein the mutation is P124J.

201. (New) The protein according to Claim 143, wherein the mutation is P125J.
202. (New) The protein according to Claim 143, wherein the mutation is P126J.
203. (New) The protein according to Claim 143, wherein the mutation is S127J.
204. (New) The protein according to Claim 143, wherein the mutation is L128J.
205. (New) The protein according to Claim 143, wherein the mutation is P129J.
206. (New) The protein according to Claim 143, wherein the mutation is S130J.
207. (New) The protein according to Claim 143, wherein the mutation is P131J.
208. (New) The protein according to Claim 143, wherein the mutation is S132J.
209. (New) The protein according to Claim 143, wherein the mutation is R133J.
210. (New) The protein according to Claim 143, wherein the mutation is L134J.
211. (New) The protein according to Claim 143, wherein the mutation is P135J.
212. (New) The protein according to Claim 143, wherein the mutation is G136J.
213. (New) The protein according to Claim 143, wherein the mutation is P137J.
214. (New) The protein according to Claim 143, wherein the mutation is S138J.
215. (New) The protein according to Claim 143, wherein the mutation is D139J.
216. (New) The protein according to Claim 143, wherein the mutation is T140J.